Pest Management Grants Final Report

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Abstract:

The Biologically Integrated Vineyard Systems (BIVS) program was established to encourage implementation of production practices which replace inputs that are either disruptive to nontarget organisms or have been found to be sources of off-site contamination. The program provides a support network to growers and industry leaders by: 1) providing a forum for discussion of issues pertaining to program guidelines and the exchange of ideas, 2)

reviewing/revising guidelines and goals for each grower participant, and 3) maintaining a network of growers and PCA's in the central San Joaquin Valley committed to implementing the BIVS program. Acreage enrolled in the program is monitored for pests and disease, and grower inputs (pesticides, herbicides, sulfur, and fertilizers) are tracked and compared to historical usage. In three years, the BIVS program has grown from 11 to 38 growers, who farm some 6,000 acres. These growers undertook strategies such as the use of compost and cover crops to improve soil health and combat spider mite outbreaks, cultivation as an alternative to pre emergent herbicides for weed control, contact herbicides (glyphosate) as an alternative to pre emergent herbicides for weed control, and lower rates of simazine to reduce the potential for groundwater contamination. Two Priority I FQPA materials were targeted for reduction by BIVS growers: propargite (for spider mite control) and simazine (for weed control). In 1998, BIVS growers reduced their use of propargite by 87% from historical use, and reduced their use of simazine by 60%. BIVS growers' yields were comparable to the county average for the 1998 season.

Executive Summary:

In California, there has been increased interest among farmers, researchers, extension advisors, pest control advisors (PCAs), regulatory agencies and consumers to implement production practices which incorporate the principles of integrated pest management (IPM), plant fertility and soil management. These programs are often described as *biologically integrated.* The Biologically Integrated Vineyard Systems (BIVS) program in the central San Joaquin Valley is part of an overall effort underway in California to address increasing environmental and public health concerns, and potential loss of pesticides due to FQPA or other reasons.

California's San Joaquin Valley is an area of phenomenal agricultural production. Crop value in Fresno County alone was $3.4 billion in 1997 (Fresno County Department of Agriculture, 1997), making it the highest agricultural producing county in the United States for the 45th consecutive year. Grapes, the leading crop in California, are also the number one crop in Fresno, Madera and Tulare counties, with a 1997 total farm gate value of over $1.2 billion. This tri-county area has some 350,000 acres of grapes, which accounts for about 40% of California's vineyard land.

Because of increasing environmental and public health concerns, potential loss of pesticides to FQPA or other reasons, and economic concerns, it is vital that grape growers in the San Joaquin Valley optimize inputs, including pesticides, water, and fertilizers. The herbicides simazine and diuron, which are the most commonly used herbicides on grape acreage, have been detected in surface and well water in Tulare and Fresno Counties. Spider mites are a major arthropod pest, and are most often treated for with propargite, which has been classified as a B2 carcinogen. A great deal of grape acreage, especially raisin acreage, is planted on marginal soils, either sandy or alkali, where vines are often water stressed and therefore more susceptible to soil borne pests such as nematodes and outbreaks of spider mites.

The BIVS program started in Fresno County in the fall of 1995 with 11 growers who committed all or part of their acreage to the program. By 1998 the program had more than tripled, with 38 growers who farm a total of about 6,000 acres. BIVS began with a gathering of interested persons for breakfast at a local restaurant, and continues to do so on a monthly basis, providing a support network for grape growers, PCAs and grape industry members.

The BIVS advisory team met with grower participants at least once a year to troubleshoot problems, and decide together how to modify production practices to meet the goals of biological integration. The team approach allows for an assemblage of opinions, including that of each grower, to be expressed in troubleshooting problems. Such teamwork leads to a more thorough understanding of the problem, and a more integrated approach to solving it within the framework of economic and environmental soundness.

There are many examples of problem solving strategies which have been undertaken by BIVS growers. Weeds are one of the pests which every grower has to contend with, and doing so with preemergent herbicides such as simazine and diuron are one of the easiest and least costly methods of weed control. Many BIVS growers have reduced their rate of simazine by a third to a half, applying the minimal amount needed to give adequate control. Many others rely more on the use of contact herbicides, especially glyphosate, because of its low risk status. Finally, cultivation using in-row cultivators and berm sweeps, is a very popular alternative to herbicides among BIVS growers.

The BIVS project demonstrated the principles of biological integration through several avenues: by regular and frequent monitoring of enrolled acreage for key pest densities, through field days, and by evaluating the impact of the program. The information collected was made available to the growers on a weekly basis, and was meant to demonstrate the use of action thresholds, and to show that regular and frequent monitoring is essential to determining the necessity and timing of treatments. Monitoring is the simplest method of eliminating unnecessary insecticide use, as growers will base treatments on action thresholds determined by pest population levels, rather than by an assumption that treatment is needed. Examples of field days include a spring weed technology day, which brought together several manufacturers of cultivation implements and contact herbicide sprayers, and field days which have compared different cover crops and cover crop blends.

The success of BIVS can be gauged by the following criteria: the level of grower participation, the substitution of biorational pesticides for broad spectrum materials, and the maintenance of adequate yields and quality. The overall impact of the program was evaluated by recording in-season pesticide and fertilizer use, compiling pest incidence, and estimating plant nutritional status, yields and quality. These were then compared to field historical averages prior to implementation of biologically integrated practices, and compared to county averages.

Some of the efforts that the 38 BIVS growers undertook in the 1998 growing season to meet BIVS objectives were:

- use of compost and cover crops to improve soil health, and combat nematode infestations and spider mite outbreaks.
- cultivation as an alternative to pre emergent herbicides for weed control.
- contact herbicides (glyphosate) as an alternative to pre emergent herbicides for weed control.
- lower rates of simazine or switch simazine to another pre emergent that does not have the potential for groundwater contamination.

For the second year, BIVS growers reduced pesticide use in two key areas: spider mite control and weed control. BIVS growers continued to perform well in the reduction of the targeted pesticides propargite (for spider mite control) and simazine (for weed control). Historically, 2613 lbs of propargite were used on the 943 acres enrolled in the program, whereas in 1998 only 338 lbs of propargite were applied on this same acreage, representing a decrease of 87%. Historically, 490 lbs of simazine were used on the 943 acres enrolled in the program, whereas in 1998 only 194 lbs were used, representing a decrease of 60%.

BIVS growers were also able to maintain yields comparable to the county average. For the San Joaquin Valley in 1998, grape yields were down about 10% from the historical average (which is about 2.25 tons of raisins/acre, and about 10 tons green/acre), and BIVS growers fit this average closely, averaging 2.14 tons of raisins/acre and 9.5 tons green/acre.

Body of Report

a. Introduction

In California, there has been increased interest among farmers, researchers, extension advisors, pest control advisors (PCAs), regulatory agencies and consumers to implement production practices which incorporate the principles of integrated pest management (IPM), plant fertility and soil management. These programs are often described as *biologically integrated,* which was first used in the Biologically Integrated Orchard Systems (BIOS) program developed jointly by the Community Alliance with Family Farmers (CAFF), Merced County almond growers, the UC Sustainable Agriculture Research and Education Program (UC SAREP), UC Cooperative Extension, the USDA's Farm Service Agency, and the federal Natural Resources Conservation Service (Bugg et al. 1995). The Biologically Integrated Vineyard Systems (BIVS) project was established in Fresno County in 1995.

BIVS promotes farming practices that encourage the beneficial organisms in the system, and encourages the use of practices and inputs that have minimal negative impact on beneficials, human health and the environment. Relatively "high risk" materials such as organophosphate and carbamate insecticides, and B2 carcinogens, are strongly discouraged. As with IPM, biological integration employs a multitude of tools, but differs in that it attempts to link pest/beneficials, soil, fertility and water management components into a systems approach. Because soil and plant health are often important in limiting the impact of pests, practices such as long term soil building, optimizing plant nutrition levels and improving irrigation efficiency can increase plant tolerance to pest attack and may also prevent pests from reaching the economic injury level. Biological BIVS recognizes that successful and sustainable production systems must maintain high yields, quality and farm profitability.

Grape growers in the San Joaquin Valley have a number of challenges in meeting the goals of biological integration. Fungicides for powdery mildew, especially sulfur, are the most heavily used inputs in grape production systems. Sulfur dust may be a contributor to air pollution. The herbicides simazine and diuron, which are the most commonly used herbicides on grape acreage, have been detected in surface and well water in Tulare and Fresno Counties (Braun & Hawkins 1991, Roux *et al.* 1991). Spider mites are a major arthropod pest, and are most often treated for with propargite, which has been classified as a B2 carcinogen (Gianessi and Anderson 1995). Mealybugs are a major pest of table grapes, and control strategies usually involve the use of organophosphate insecticides. Fortunately, other major insect pests, such as omnivorous leafroller and leafhoppers, can be treated with relatively low risk materials.

The Biologically Integrated Vineyard Systems (BIVS) project was established in 1995 for Fresno County grape growers. The BIVS program was designed to assure growers are using the most efficient and environmentally sound practices possible. Growers involved in the BIVS program are encouraged to optimize their inputs by soil, water and plant tissue testing, by regular and frequent monitoring for key pests during the season, and by treating only when pest populations reach economic thresholds. In addition, health, food safety, and offsite pollution risks are minimized by avoiding the use of disruptive, groundwater-contaminating or potentially carcinogenic materials. BIVS growers are expected to maintain yields, quality, and profitability with respect to conventional growers. The program is not expected to reduce pest damage, but rather to match levels of pest control and fertility achieved by conventional growers while keeping negative impacts to a minimum, and is designed to be equivalent economically with conventional practices.

BIVS has and will continue to help central San Joaquin Valley grape growers become more efficient with their inputs, reducing the potential of negative consequences from farming. Biologically integrated programs such as ours are underway for nut crops in Merced, Yolo, Stanislaus, and Madera Counties (BIOS), grapes in San Joaquin County (Lodi-Woodbridge BIFS), and vegetables on the westside of the San Joaquin Valley (BIFS). BIVS and these other programs provide growers a forum to discuss pest and fertility management strategies to meet the goals of efficiency and profitability, as well as giving growers the opportunity to increase their knowledge of pests and natural enemy biology and vineyard ecology. These programs are at the forefront of implementing safe, environmentally sound, and profitable farming systems. Our goal is to be an example for other California grape growers.

b. Materials and Methods

Monthly meetings BIVS provided a forum for discussion of issues, exchanges of ideas, and support for incipient programs through monthly breakfast meetings. Agenda items consisted of a discussion on current vineyard management events such as cover cropping, fertilization, or pest management. Speakers from various institutions and agencies were invited to give presentations on these topics.

Strategies All BIVS growers are familiar with the goals of implementing safe, environmentally sound, and profitable farming systems. With this information, each grower met with the advisory team in the winter of 1997/98 to develop or refine a set of customized biologically integrated management practices. These goals are designed to help them make farm management decisions in the upcoming season. Growers designate a portion or all of their vineyards (from 5-85 acres) to be managed under BIVS guidelines. New growers meet with the advisory team on farm to lay the groundwork for participation in the program. Veteran growers meet with the advisory team in groups of three or four to review and revise the individual management practices they have been used over the past year.

Monitoring acreage and documenting pesticide use Monitoring began in May of each year and continued weekly until harvest for powdery mildew, leafhoppers, omnivorous leafroller (OLR), spider mites, and mealybugs. At mid-season, weed density and diversity was estimated. Soil samples were taken in December 1998 and analyzed for texture, salts and organic matter. Vine tissue testing was performed by taking petiole samples at bloomtime and analyzing for nitrate-nitrogen, potassium, zinc, and boron. At harvest, berry weight, soluble solids (sugar), yield, and quality were estimated. Pest management strategies were tabulated, and inputs such as herbicides, insecticides and miticides were compiled and compared to historical usage.

Field days Several field days were hosted by BIVS every year demonstrating practices or technologies which may help growers achieve the goals outlined above. Four field days were held in 1998. A cover crop field day was held in conjunction with Sun-Maid in March when about 25 participants had an opportunity to see several blends of cover crops growing in sandy soil with and without fertilizer. A weed control field day was held in March, and about 60 participants observed the demonstration of a variety of mechanical weed cultivators, as well as two low volume herbicide sprayers. In July, BIVS teamed up again with Sun-Maid to host two mite identification workshops, which was attended by about 180 growers and PCAs. A spray technology field day was held in June, with about 70 people coming out to view the demonstration of nine different conventional and low volume sprayers.

c. *Results*

Monthly meetings

BIVS held breakfast meetings each month. A list of speakers and topics for the most recent funding year is as follows:

Month/Year	Speaker	Topic
May 1998	John Weddington	Water management
June 1998	Michael Costello	Spider mite management
July 1998	Bill Peacock	Ripening the 1998 crop
August 1998	John Tufenkjian/Jon Holmquist	Harvest practices
October 1998	L. Peter Christensen	Vine fertility and fertilization
November 1998	Michael Costello	Pest monitoring results from the 1998 season
December 1998	Tim Prather	Simazine study results
January 1999	Tim Prather	BIVS weed survey results
February 1999	Michael Costello	BIVS cover crop study results
March 1999	Jeff Mitchell	Soil Management/BIVS soil survey results
April 1999	George Leavitt	Vineyard disease management
May 1999	Ron Brase/Joe Kretsch/Michael Costello	Bloomtime activities

Strategies

Table 1 summarizes the target areas of each BIVS grower and the strategies discussed by the management team and each grower.

Monitoring acreage and documenting pesticide use

All of the information gathered during the season, including quantity of inputs, pest incidence, yield and fruit quality and soil quality, are summarized in Tables 2-7. Table 8 summarizes pesticide use.

Table 2 summarizes variegated leafhopper population density from May-August. In Table 2, peak leafhopper nymphal density is boldfaced; treatment threshold is generally recognized at between 15-20 nymphs/leaf for raisin and wine grapes. Only seven of the 38 BIVS growers treated for leafhoppers, and all of these used imidacloprid (Provado®), which is not known to be disruptive to vineyard natural enemies.

Table 3 summarizes spider mite infestation for the BIVS growers in 1998. In Table 3, peak Pacific mite infestation is boldfaced; treatment threshold is considered to be 50% infestation. Five of the 38 BIVS growers chemically treated for mites, using either propargite (Omite®) or dicofol (Kelthane®). Propargite is a targeted pesticide because it is on the priority I list under FQPA. Table 4 shows powdery mildew infestation for BIVS growers.

Table 5 shows the harvest statistics of °Brix (sugar accumulation), berry weight, and yield (either raisin or fresh [green] weight). Grape yields were down about 10% from the historical average (which is about 2.25 tons of raisins/acre, and about 10 tons green/acre) throughout the central valley in 1998, and BIVS growers fit this average closely, averaging 2.14 tons of raisins/acre and 9.5 tons green/acre.

Table 6 shows the petiole (grape leaf tissue) concentration of the four most significant nutrients for grape growers: potassium, boron, zinc and nitrogen. Many BIVS growers were low in potassium, which is probably a carry-over from the high crop in 1997. Typically, the higher the crop load, the more potassium that is needed. Most growers were within the acceptable range for nitrate-nitrogen, and only two had excessive levels.

Table 7 summarizes the soil analyses conducted for BIVS growers in 1998. These were conducted to establish a base line for soil quality, and to help the management team and BIVS growers develop strategies for soil management. The most consistent soil shortfall among BIVS growers is low organic matter (OM). San Joaquin Valley soils have relatively low OM naturally, but conventional farming practices exacerbate this. We'd like to see 1% OM in SJV vineyards, and only one BIVS grower currently has this level. Most BIVS growers had favorable soil salt balances, which can be seen in the EC and SAR columns.

Table 8 summarizes BIVS growers' pesticide use for three key areas: spider mite control, weed control and powdery mildew control. BIVS growers continued to perform well in the reduction of the targeted pesticides propargite (for spider mite control) and simazine (for weed control). Historically, 2613 lbs of propargite were used on the 943 acres enrolled in the program, whereas in 1998 only 338 lbs of propargite were applied on this same acreage, representing a decrease of 87%. Historically, 490 lbs of simazine were used on the 943 acres enrolled in the program, whereas in 1998 only 194 lbs were used, representing a decrease of 60%.

d. Discussion

The BIVS project has demonstrated the principles of biological integration through several avenues: by regular and frequent monitoring of enrolled acreage for key pest densities, through field days, and by evaluating the impact of the program. The information collected was made available to the growers on a weekly basis, and was meant to demonstrate the use of action thresholds, and to show that regular and frequent monitoring is essential to determining the necessity and timing of treatments. Monitoring is the simplest method of eliminating unnecessary insecticide use, as growers will base treatments on action thresholds determined by pest population levels, rather than by an assumption that treatment is needed.

BIVS practices were also demonstrated through field days. Biologically integrated practices are more readily adopted and easily implemented if they are physically demonstrated to growers.

The success of BIVS can be gauged by the following criteria: the level of grower participation, the substitution of biorational pesticides for broad spectrum materials and the maintenance of adequate yields and quality. BIVS participation tripled in its first three years, use of targeted pesticides declined by over half, and yields and quality for the group as a whole were similar to the county average.

e. Summary and Conclusions

Biological integration in crop production recognizes that agricultural systems are made up of many biological components, including not only the crop, but also the soil dwelling organisms (microbes, nematodes and arthropods), the organisms that exist on the crop, and even the weeds. BIVS promotes farming practices that encourage the beneficial organisms in the system, and encourages the use of practices and inputs that have minimal negative impact on beneficials, human health and the environment. High risk materials, such as organophosphate and carbamate insecticides, B2 carcinogens and herbicides which have been detected in ground water, are strongly discouraged. As with IPM, biological integration employs a multitude of tools, but differs in that it attempts to link pest/beneficials, soil, fertility and water management components into a systems approach. Because of the potential loss of FQPA priority materials, it's possible that many if not most chemicals available to growers will be more selective, have shorter residuals and be more expensive. Programs such as BIVS can help grape growers adapt to these changes by making them aware of IPM principles such as economic injury levels and increase precision in treatment timing. Because soil and plant health are often important in limiting the impact of pests, practices that BIVS are emphasizing such as long term soil building, optimizing plant nutrition levels and improving irrigation efficiency can increase plant tolerance to pest attack and prevent economic damage.

Implementing effective IPM systems is one of the core objectives of BIVS. IPM promotes regular and frequent monitoring for pests and the use of action thresholds to determine treatment timing. Although much progress has been made over pest control programs based on calendar applications of broad spectrum pesticides, the implementation of a full IPM program is something that has only been attained by a minority of growers in the central SJV. Whereas most grape growers in the SJV do have their fields checked at some point in the season, it is usually not frequent enough.

The BIVS program contributes to environmental quality in several ways: first, by implementing IPM principle of monitoring and treatment thresholds, which eliminates many preventative or insurance sprays. Secondly, by using the safest and least disruptive materials, non-target organisms are spared and the risk of offsite pollution is minimized. Lastly, if treatment is warranted, the minimum amount needed for efficacy is used. This IPM approach is correctly identified as reduced pesticide use risk for growers and their workers, the environment, and consumers of grapes and grape products.

We have gauged the success of BIVS project using the following criteria: the level of grower participation, the substitution of cultural controls, biological controls, or biorational pesticides for broad spectrum materials, and the maintenance of adequate yields and quality. We have been successful in all categories. BIVS membership has tripled in the three years since its inception (11 members in 1996, 23 in 1997 and 38 in 1998). Many more individuals who are not officially enrolled in the program participate in monthly meetings and field days, and we have a combined mailing list of over 80 people. We have recorded in-season pesticide use, compared it to field historical averages prior to implementation of biologically integrated practices, and found a trend of decreasing use of high risk materials in the first two years of the program. We have collected data on fruit yields and quality and found them to be comparable with county averages.

References

Bugg R., J. Dietrick, C. Ingels, T. Johnson, R. Jurgens, T. Nelson, L. Pottinger and M. Werner. 1995. BIOS for almonds: a practical guide to biologically integrated orchard systems management. Community Alliance with Family Farmers Foundation and Almond Board of California.

Braun, A. L. and L.S. Hawkins. 1991. Presence of bromacil, diuron and simazine in surface water runoff from agricultural fields and non-crop sites in Tulare County California. Department of Food and Agriculture, State of California, PM 91-1.

Fresno County Department of Agriculture. 1997. Agricultural Crop and Livestock Report.

Gianessi, L.P. and J.E. Anderson. 1995. Potential economic impacts of Delaney Clause implementation on U.S. agriculture. National Center for Food and Agricultural Policy Technical Report #TR-95-1.

Roux, P.H., R.L. Hall, and R.H. Ross Jr.1991. Small scale retrospective ground water monitoring study for simazine in different hydrogeological settings. Ground Water Monitoring Review 11: 173-181.

List of Publications Produced

Costello, M.J. and M.A. Mayse. 1999. Biologically Integrated Vineyard Systems: Integrating grape pest, soil and plant fertility management. Proceedings of the Plant and Soil Conference, California Chapter of the American Society of Agronomy, Visalia, CA, January 1999.

Appendix

Table 1. BIVS growers in 1998, years in the program, number of acres in the program, target areas and biologically integrated strategies.

GROWER	YEARS	ACRES IN PROGRAM	TARGET AREAS	BIVS STRATEGIES
Alles	1	60	bunch rot	Pre-bloom gibberellic acid (loosens clusters)
Allred	2	20	bunch rot, OLR, leafhoppers	Monitoring, OLR timing, copper/sulfur dust for rot, Roundup only
Arakelian	1	58	establishing young vines, soil management	Grass cover crops to decrease soil nitrogen, improve soil tilth
Bachant	1	40	soil, nematodes	Compost
Bennett	2	10	spider mites, poor vine growth	Monitoring, cover crops
Bishel	2	54	spider mites, leafhoppers	Monitoring, releasing predatory mites
Bitter	2	70	Mildew	Use of mildew model
Boren	2	10	weeds, spider mites	Roundup only, look at alternatives to propargite
Britz	1	80	spider mites, soil health	Cut back on sulfur use to help prevent mite outbreaks
Campbell	2	32	weeds, spider mites	Roundup only, release predatory mites
Chooljian	3	40	weeds, leafhoppers	Decrease simazine use; monitoring
Crosno	2	8	weeds, spider mites	In-row tillage; monitoring
CSUF	1	20	weeds, leafhoppers	Monitoring
Feaver	2	10	OLR, spider mites, soil fertility	OLR timing; cover crop and non-tillage
Felker	1	7	vine growth, soil fertility, mites	Monitoring; soil amendments
Forbes	3	10	spider mites, leafhoppers	Use of overhead sprinklers for mites; decrease nitrogen fertilizer rate
Fujioka	2	18	spider mites, powdery mildew	Monitoring, use of mildew model

Harper	2	8	bunch rot, nematodes, phomopsis	Cover crops
Holmquist	1	20	weeds, mildew	Use of mildew model
Jue	3	30	spider mites, weeds	Cover crops, alternatives to propargite, in-row tillage
Kangas	3	4	weeds, leafhoppers, nematodes	Decrease simazine use; monitoring, drip irrigation
Khasigian	3	10	nematodes, leafhoppers, mites, weeds	Compost, monitoring
Lightner	2	10	poor vine growth	Compost, Roundup only
Loewen	2	15	weeds, soil fertility	Roundup only
Meisner	3	20	OLR, leafhoppers, spider mites	Decrease simazine; monitoring, cover crops, minimum tillage
Munro	1	20	soil fertility, nematodes	In-row tillage
E. Nazaroff	1	5	soil fertility	In-row tillage
N. Nazaroff	1	5	mildew	Cover cropping
Parvanian	1	10	mildew	Reduce simazine
Sani	1	10	spider mites, OLR	Use of mildew model, OLR timing, monitoring
Seibert	2	20	spider mites	Release predatory mites, oil for spider mites
Shubian	1	20	OLR	Reduce simazine use
Smith	3	85	weeds, spider mites	Cover crops, monitoring, Roundup only
Topjian	2	53	weeds	In-row tillage, monitoring
Tufenkjian	3	20	weeds, leafhoppers	Roundup only, monitoring
Van Gundy	3	31	mildew, nematodes	Compost
Vasquez	2	10	nematodes, spider mites	Compost, monitoring, oil for leafhoppers
Wulf	3	10	OLR, soil fertility	Roundup only, OLR timing

Table 2. Variegated leafhopper population density (average number of nymphs/leaf), BIVS sites, 1998.

Week of→ Grower↓	5/25	6/1	6/8	6/15	6/22	6/29	7/6	7/13	7/20	7/27	8/3	8/10	8/17	Materials Used
Alles	0.1	0.2	0.9	1.9	3.9	3	0.8	0.17	0.7	7.4	18.5	0.1	0	n/a
Allred	0.03	0.13	0.33	0.4	0.9	1.3	0.67	0.07	2	3.6	n/a	7	8	None
Arakelian	0	0.03	0.37	0.4	0.13	0.13	0	0.07	0.1	0.1	2	0.07	0.97	Provado @ 0.45 oz/ac pre-harvest (mid-September)
Bachant	0.07	n/a	0.13	0.33	0.33	0.17	0.03	n/a	0.13	0.8	2.4	1.3	0.23	n/a
Bennett	0	1.7	1.3	1.1	0.93	1.9	0.87	0.67	1	4.5	10.1	10.7	1.9	Provado @ 0.75 oz/ac pre-harvest (August 29)
Bishel	0.23	0.2	0.3	0.33	0.23	0.2	0.1	0.03	0.3	0.33	0.23	0.2	0.23	None
Bitter	0.17	0.13	0.63	0.53	0.6	0.8	0.4	0	0	0.7	2	1.5	0.43	None
Boren	0.03	0.13	0.43	0.1	0.17	0	0.07	0.07	0.27	0.17	0.23	0.33	0.3	None
Britz	0	0.03	0.37	0	0.07	0.07	0.53	0.1	0.17	0.67	1.6	2.6	1.7	None
Campbell	0	0.5	1.6	0.9	0.5	1.3	0.2	0.13	1.5	1.4	0.4	0.03	0.17	None
Chooljian	0	0.03	0.4	1	1.1	0.87	0.37	0.2	0.37	2.3	2.7	13		n/a
CSUF-Conventional	n/a	n/a	0	0.5	0.5	0.2	0.37	0.2	0.33	6	15	n/a	n/a	Provado @ 0.5 oz/ac August 18
CSUF-Sustainable	n/a	n/a	0.03	0.03	0.73	0.1	0.17	0.13	0.2	0.8	10.1	n/a	n/a	None
Crosno	0.2	1	0.8	0.63	1.2	2.3	0.23	0	n/a	n/a	n/a	n/a	n/a	None
Feaver	0.03	n/a	0.5	0.8	1.9	1.1	0.8	0.13	0.23	n/a	n/a	n/a	n/a	None
Felker	0	0.03	0.23	0.27	0.03	0.57	0.1	0.03	0	0.13	0.77	n/a	n/a	None
Forbes-S of 144	0.03	0.3	0.8	0.17	1.3	0.47	0.27	0.63	0.07	1.5	2.3	11	n/a	Provado @ 0.5 oz/ac August 17
Forbes-N of 144	0	0.2	0.9	0.17	1.1	0.73	0.47	0.27	3.2	10.7	6.4	16.5	n/a	Provado @ 0.5 oz/ac August 17
Fujioka	0	0.37	0.63	0.33	0.23	0.03	0.07	0.03	n/a	0.8	1.2	1.2	1.1	None
Harper	0	0.17	1.3	0.57	0.7	1.9	0.53	0.13	2.3	5	10.3	10.1	n/a	None
Canandaigua	0.23	0.13	0.27	0.13	0.13	0.03	0.13	0.03	0	0.07	0	0.17	0.1	None
Jue	0	0	0.23	0.1	0.13	0	0.07	0	0.13	0	0.03	0	0.03	None
Kangas	0.03	0.63	0.93	1.8	1.6	1.3	0.4	0	0.8	3.3	5.1	6.7	3.3	None
Khasigian	0	0.43	1.2	1.2	0.97	0.43	0.33	0.17	0.67	4.6	2.8	0.03	0	n/a
Lightner	0.47	0.23	0.93	1.1	0.57	1.1	0.8	0.27	0.57	3.7	7.9	9.3	10.3	None

Table 2 (con't)

Week of→ Grower↓	**5/25**	**6/1**	**6/8**	**6/15**	**6/22**	**6/29**	**7/6**	**7/13**	**7/20**	**7/27**	**8/3**	**8/10**	**8/17**	**Materials Used**
Loewen	0.03	0	0.17	0.37	0.07	0.27	0.07	0	0.3	0.17	0.97	1	0.53	None
Meisner	0	0.4	0.83	0.17	0.73	1.4	0.43	0	0.23	0.7	3.6	8.5	2.7	None
Munro	0	0.3	0.9	0.37	0.6	0.4	0.3	0	0.33	2.1	7.1	n/a	n/a	Provado @ 0.6 oz/ac July 5 & August 27
N. Nazaroff	0	0.13	0.27	0.33	0.33	0.4	0.2	0.1	0.63	0.67	6.5	0.2	n/a	None
E. Nazaroff	0	0.13	0.77	0.4	0.8	0.33	0.1	0.03	0.37	0.9	1.3	0.53	n/a	None
Parvanian	0.03	0.37	0.37	1.5	1.6	0.83	0.57	0.4	0.6	3.6	3.7	3.8	1.1	None
Sani	0	0.17	0.37	2.6	2.3	1.5	0.6	0.03	0.2	4	2.4	1.8	8.9	None
Seibert	0	n/a	0.33	0.43	0.5	0.67	0.2	0.03	0.07	2.6	6.3	5.3	4.3	None
Shubian	0	0.13	0.47	0.47	1	1	0.2	0.13	0.23	0.97	4.6	6	n/a	None
Smith	0	0.57	0.17	0.47	0.4	0.1	0.2	0	0.07	0.1	0.9	0.27	0.47	None
Topjian	0	0	0.47	0.17	0.3	0.5	0.1	0.2	0.3	0.97	0.37	0.03	0	Provado @ 0.38 oz/ac June 1
Tufenkjian-Sanger	0	0.03	0.43	0.3	0.7	0.2	0.03	0.13	0.67	0	1.3	n/a	n/a	n/a
Tufenkjian-Clovis	0.23	0.07	0.8	0.67	0.73	0.4	0.27	0.1	0.9	7.9	11.3	6	2.6	n/a
VanGundy	0	0.27	0.83	2.7	1.1	0.97	0.43	0	0.5	2.4	1.6	0.27	0.1	None
Vasquez	0.27	1	1.9	2.6	5.1	2.8	0.7	0.23	6.2	20.1	15.4	1	0.1	None
Wulf	0.03	0.07	0.07	0.1	0.5	0.53	0.33	n/a	0.03	0.27	1.7	n/a	2.5	None

[1]Peak leafhopper density is boldfaced. The treatment threshold is generally recognized at between 15-20 nymphs/leaf for raisin and wine grapes.

Table 3. Pacific mite infestation (average percent of leaves with pacific mites), 1998 season[1].

Week of→ Grower↓	5/25	6/1	6/8	6/15	6/22	6/29	7/6	7/13	7/20	7/27	8/3	8/10	8/17	8/24	Materials Used
Alles	0	0	0	0	0	0	0	0	0	0	3.3	0	**13.3**	n/a	None
Allred	0	0	0	0	0	0	0	0	0	0	n/a	0	0	n/a	None
Arakelian	0	0	0	0	0	0	0	0	0	0	0	0	0	n/a	None
Bachant	0	n/a	0	0	0	0	0	n/a	6.7	3.3	3.3	16.7	**43.3**	n/a	None
Bennett	0	0	0	0	0	0	0	13.3	3.3	30	30	**63.3**	50	n/a	None
Bishel	0	0	0	0	3.3	0	3.3	0	10	23.3	0	23.3	**36.7**	n/a	Predator mites
Bitter	3.3	0	0	0	0	0	3.3	13.3	6.7	6.7	16.7	**46.7**	43.3	n/a	None
Boren	0	0	6.7	0	0	0	0	3.3	16.7	13.3	20	23.3	**56.7**	n/a	None
Britz	0	0	0	0	0	6.7	0	10	26.7	23.3	30	**56.7**	53.3	n/a	None
Campbell	0	0	6.7	10	6.7	13.3	30	43.3	46.7	16.7	10	**40**	26.7	n/a	summer oil July 11 (rows 71-98) & Omite @ 8 lb/ac July 25 (rows 1-54, 71-98)
Chooljian	0	0	0	0	0	0	0	0	0	0	6.7	**10**	n/a	0	None
CSUF-Conventional	n/a	n/a	0	0	3.3	0	0	0	0	0	**3.3**	n/a	n/a	0	None
CSUF-Organic	n/a	n/a	0	0	0	0	0	0	0	0	3.3	n/a	n/a	**3.3**	None
Crosno	0	0	0	0	0	3.3	**13.3**	3.3	n/a	n/a	n/a	n/a	n/a	n/a	Omite @ 6 lb/ac July 6
Feaver	3.3	n/a	0	0	0	0	0	0	0	n/a	n/a	n/a	n/a	n/a	Omite @ 4 lb/ac July 13
Felker	0	0	0	0	0	0	0	3.3	3.3	3.3	0	n/a	n/a	**3.3**	None
Forbes	0	0	0	10	3.3	0	6.7	10	6.7	18	16.7	n/a	n/a	**96.7**	None
Fujioka	3.3	0	0	0	0	0	0	0	n/a	3.3	3.3	0	**16.7**	n/a	None
Harper	0	6.7	0	0	0	0	3.3	0	0	0	13.3	**13.3**		6.7	None
Holmquist	0	0	0	0	0	0	0	0	0	0	0	0	0	n/a	None
Jue	0	0	0	0	0	6.7	0	0	13.3	3.3	3.3	33.3	**40**	n/a	None
Kangas	0	0	0	0	0	0	0	0	3.3	0	**43.3**	40	23.3	n/a	None
Khasigian	0	0	0	0	0	0	0	0	3.3	0	**3.3**	0	0	n/a	None
Lightner	0	0	0	0	3.3	0	0	0	3.3	3.3	0	13.3	**13.3**	n/a	None

Table 3, con't

Week of→ Grower↓	**5/25**	**6/1**	**6/8**	**6/15**	**6/22**	**6/29**	**7/6**	**7/13**	**7/20**	**7/27**	**8/3**	**8/10**	**8/17**	**8/24**	**Materials Used**
Loewen	0	3.3	0	0	0	0	0	0	6.7	0	3.3	**13.3**	3.3	n/a	None
Meisner	0	0	0	0	0	0	3.3	0	0	0	6.7	0	**23.3**	n/a	None
Munro	0	3.3	0	0	0	0	0	0	0	0	0	n/a	n/a	0	None
N. Nazaroff	0	3.3	0	3.3	0	0	0	0	0	6.7	3.3	20	n/a	**50**	None
E. Nazaroff	0	0	0	0	0	6.7	0	0	0	6.7	10	**13.3**	n/a	6.7	Kelthane @ 1.9 pt/ac July 1 (spot sprayed)
Parvanian	0	0	0	0	0	0	0	0	0	0	0	0	0	n/a	None
Sani	0	0	0	20	10	23.3	33.3	3.3	73.3	30	**80**	3.3	43.3	n/a	Omite @ 5 lb/ac July 22 (spot sprayed)
Seibert	0	n/a	0	0	3.3	0	3.3	0	3.3	10	23.3	16.7	**30**	n/a	None
Shubian	0	0	0	0	0	0	0	3.3	0	0	0	**6.7**	n/a	3.3	None
Smith	0	0	3.3	0	3.3	0	3.3	0	0	0	3.3	3.3	**3.3**	n/a	None
Topjian	0	0	0	0	0	3.3	10	3.3	6.7	36.7	26.7	46.7	**60**	n/a	None
Tufenkjian-Sanger	0	0	0	0	0	0	0	0	**13.3**	0	0	n/a	n/a	n/a	None
Tufenkjian-Clovis	0	0	0	0	0	0	0	0	3.3	0	**3.3**	0	0	n/a	None
VanGundy	0	0	0	6.7	10	10	0	53.3	6.7	23.3	**66.7**	23.3	30	n/a	None
Vasquez	0	0	0	0	0	0	3.3	10	6.7	23.3	46.7	**53.3**	40	n/a	Predator mites
Wulf	0	0	0	0	0	0	0	n/a	0	3.3	**16.7**	n/a	10	n/a	None

[1]Peak Pacific mite infestation is boldfaced. Treatment threshold is considered to be 50% infestation.

Table 4. Powdery mildew infestation (average percent of bunches with powdery mildew), 1998 season.

Week of→ Grower↓	6/22	6/29	7/6	7/13	7/20	7/27	8/3	8/10	8/17
Alles	n/a	n/a	1%	6%	3%	4%	5%	3%	5%
Allred	20%	20%	35%	22%	39%	9%	n/a	0%	5%
Arakelian	0%	1%	8%	4%	3%	2%	0%	0%	n/a
Bachant	n/a	4%	15%	n/a	30%	14%	9%	8%	n/a
Bennett	0%	18%	42%	32%	10%	25%	0%	n/a	n/a
Bishel	n/a	1%	20%	35%	36%	40%	20%	2%	10%
Bitter	n/a	18%	33%	73%	73%	74%	55%	19%	32%
Boren	n/a	n/a	7%	14%	32%	10%	7%	6%	4%
Britz	n/a	n/a	n/a	5%	17%	12%	5%	0%	4%
Campbell	4%	n/a	5%	9%	15%	11%	0%	0%	8%
Chooljian	2%	23%	74%	n/a	34%	36%	3%	n/a	n/a
CSUF-Conventional	0%	2%	18%	26%	12%	3%	2%	n/a	n/a
CSUF-Organic	0%	3%	41%	46%	11%	15%	2%	n/a	n/a
Crosno	1%	2%	17%	25%	n/a	n/a	n/a	n/a	n/a
Feaver	n/a	n/a	42%	24%	22%	n/a	n/a	n/a	n/a
Felker	21%	26%	n/a	28%	45%	42%	16%	n/a	n/a
Forbes	3%	39%	68%	76%	56%	53%	n/a	n/a	n/a
Fujioka	n/a	2%	17%	42%	n/a	30%	18%	8%	20%
Harper	16%	35%	52%	39%	34%	26%	11%	n/a	n/a
Holmquist	65%	81%	n/a	82%	63%	75%	66%	8%	18%
Jue	n/a	n/a	n/a	3%	13%	12%	7%	n/a	2%
Kangas	4%	3%	31%	25%	18%	8%	3%	0%	29%
Khasigian	7%	3%	39%	32%	21%	10%	15%	4%	3%
Lightner	n/a	56%	70%	71%	74%	59%	37%	14%	36%
Loewen	11%	4%	40%	24%	37%	27%	8%	0%	29%
Meisner	7%	3%	10%	6%	12%	4%	11%	3%	n/a
Munro	11%	1%	15%	16%	42%	11%	3%	n/a	n/a
N. Nazaroff	13%	27%	11%	18%	23%	18%	10%	12%	n/a
E. Nazaroff	3%	36%	43%	31%	65%	50%	31%	29%	n/a
Parvanian	n/a	37%	68%	82%	61%	40%	50%	53%	61%
Sani	7%	12%	66%	21%	27%	31%	56%	0%	6%
Seibert	n/a	3%	20%	25%	16%	31%	n/a	22%	8%
Shubian	8%	4%	15%	21%	28%	30%	36%	9%	n/a
Grower	6/22	6/29	7/6	7/13	7/20	7/27	8/3	8/10	8/17
Smith	n/a	13%	54%	83%	78%	51%	39%	44%	n/a
Topjian	30%	61%	87%	100	81%	71%	20%	27%	77%
Tufenkjian-Sanger	0%	11%	25%	16%	27%	19%	0%	n/a	n/a
Tufenkjian-Clovis	4%	3%	56%	35%	31%	11%	9%	2%	10%
VanGundy	n/a	n/a	30%	29%	15%	2%	0%	5%	17%
Vasquez	n/a	2%	4%	10%	13%	7%	0%	0%	1%
Wulf	n/a	0%	n/a	n/a	23%	9%	7%	n/a	1%

Table 5. °Brix, berry weight and yield on on BIVS acreage, 1998.

Grower & Variety	°Brix	Average weight/berry (g)	Raisin tons/acre[1,2]	Green tons/acre[3]
Alles-T.S.	19.2	2.03	3.83	
Allred-Grenache	23.0	1.99		10.01
Arakelian-Chardonnay	n/a	n/a		n/a
Bachant-T.S.	22.2	2.24		8.56
Bennett-T.S.	21.6	2.08	1.32	
Bishel-T.S.	19.7	2.37	n/a	
Bitter-T.S.	18.6	2.15	2.01	
Boren-T.S.	18.7	1.87	2.7	
Britz-T.S.	19.7	2.13	2.18	
Campbell-T.S.	20.1	1.92		n/a
Chooljian-T.S.	20.6	1.96		7.97
CSUF-Conventional Barbera	23.7	3.26		7.12
CSUF-Organic Barbera	22.6	2.98		8.35
Crosno-T.S.	n/a	n/a		n/a
Feaver-T.S. dried-on-the-vine	21.3	1.8	1.85	
Felker-T.S.	n/a	n/a	n/a	
Forbes-T.S.	20.6	1.81		10.86
Fujioka-T.S.	22.0	2.13		9.41
Harper-Fiesta	17.4	2.18		14.04
Canandaigua-Chardonnay	n/a	n/a		n/a
Jue-T.S.	17.2	1.94		9.32
Kangas-T.S.	19.2	2.00		9.75
Khasigian-T.S.	20.6	1.95	1.96	
Lightner-T.S.	19.6	2.23		n/a
Loewen-T.S.	19.7	1.77		10.5
Meisner-T.S.	20.4	2.38		11.11
Munro-T.S.	17.9	n/a	1.81	

Table 5, con't.

Grower	°Brix	Average weight/berry (g)	Raisin tons/acre[1,2]	Green tons/acre[3]
E. Nazaroff-T.S.	20.2	1.78	1.76	
N. Nazaroff-T.S.	20.4	2.09	n/a	
Parvanian-T.S.	19.7	1.67		10.31
Sani-T.S.	18.9	2.1	2.88	
Seibert-T.S.	21.1	2.18	2.63	
Shubian-T.S.	19.7	2.05	2.44	
Smith-T.S.	21.5	1.82		6.99
Topjian-T.S.	19.6	1.9	1.36	
Tufenkjian-Flames Sanger	n/a	n/a		n/a
Tufenkjian-T.S. Clovis	20.8	1.97		n/a
Van Gundy-T.S.	18.9	2.08	2.54	
*Vasquez-T.S. compost	n/a	n/a	1.0	
*Vasquez-T.S. no compost	n/a	n/a	.92	
Wulf-T.S.	20.6	2.11		8.57

[1]Raisin yield is adjusted to 14% moisture

[2]Average raisin yield throughout the San Joaquin Valley is roughly 2.25 tons/acre.

[3]Average green tonnage for San Joaquin Valley Thompson Seedless averages roughly 10 tons/acre.

*Unadjusted for moisture

Table 6. Petiole concentrations of the four most significant grape nutrients, BIVS growers, 1998.

GROWER & VARIETY	POTASSIUM (%)	BORON (PPM)	ZINC (PPM)	NITRATE (PPM)
ALLES-T.S	1.24	33	23	1110
ALLRED-GRENACHE	1.33	28	19	340
ARAKELIAN-CABERNET	4.17	30	88	50
BACHANT-T.S	0.95	24	39	40
BENNETT-T.S	1.23	25	99	180
BISHEL-T.S.	1.84	27	46	240
BITTER-T.S.	1.96	29	38	60
BOREN-T.S.	1.82	35	41	1150
BRITZ-T.S.	2.06	32	34	160
CAMPBELL-T.S.	1.15	35	24	590
CHOOLJIAN-T.S.	1.63	30	20	880
CROSNO-T.S.	0.59	n/a	n/a	100
CSUF-BARBERA CONVENTIONAL	1.86	36	49	40
CSUF-BARBERA ORGANIC	2.25	36	30	10
FEAVER-T.S.	1.14	33	28	770
FELKER-T.S.	2	29	56	960
FORBES-T.S.	0.88	29	34	640
FUJIOKA-T.S.	2.3	40	30	2220
HARPER-FIESTA	1.33	34	18	310
CANANDAIGUA-CHARDONNAY	3.09	31	48	1050
JUE-T.S.	2.34	31	41	40
KANGAS-T.S.	0.95	30	24	620
KHASIGIAN-T.S.	2.07	27	34	390
LIGHTNER-T.S.	1.29	26	38	440
LOEWEN-T.S.	1.35	29	23	220
MEISNER-T.S.	1.88	42	34	1640
MUNRO-T.S.	2.01	20	45	60

Nutrient ranges-Thompson Seedless grapes

	Potassium	Boron	Zinc	Nitrate
Deficient	<1.0	<25	<15	<350
Questionable	1.0-1.5	26-30	15-26	350-500
Adequate	>1.5	>30	>26	500-1200
Excessive	n.a.	>100	n.a.	1200-3000

Table 7. Soil analyses for BIVS growers, 1998.

Grower	SP	pH	EC	SAR	Organic Matter (%)	Sand (%)	Silt (%)	Clay (%)
Alles	22	6.5	0.51	0.61	0.36	78	20	2
Allred	20	6.6	0.38	0.33	0.39	71	24	5
Arakelian	31	6.8	2.28	0.94	0.55	60	27	13
Bachant	20	6.7	0.82	0.56	0.34	76	20	4
Bennett	20	7.1	0.2	0.36	0.17	88	11	1
Bishel	28	6.9	0.87	0.64	0.74	71	22	7
Bitter	26	6.8	0.52	0.34	0.48	77	19	4
Boren	24	8.1	0.67	4.00	0.20	81	15	4
Britz-Sand Ranch	26	7.6	2.52	1.75	0.44	79	17	4
Campbell	21	7.6	0.41	1.12	0.23	81	9	10
Canandaigua (Holmquist)	20	6.6	1.09	2.20	0.50	70	24	6
Chooljian-Del Rey	22	7.3	0.54	1.21	0.28	81	16	3
Crosno	22	7.2	0.47	0.52	0.36	83	14	3
Feaver	21	7	0.32	0.27	0.36	63	33	4
Felker	22	7.9	5.06	13.5	0.27	81	17	2
Forbes	24	8	0.69	2.06	0.47	62	36	2
Fujioka	26	7.5	1.30	1.10	0.60	72	24	4
Harper	22	6.9	0.58	0.68	0.32	76	20	4
Jue-strong vines	28	7.7	2.70	1.39	0.91	n/a	n/a	n/a
Jue-weak vines	35	7.7	3.00	1.92	1.20	n/a	n/a	n/a
Kangas	21	7.3	0.56	1.61	0.17	84	12	4
Khasigian	20	6.4	0.28	0.30	0.34	77	18	5
Lightner	31	6.2	2.36	0.56	0.79	63	28	9
Loewen	27	7.4	2.08	1.19	0.54	58	37	5
Meisner	24	6.2	0.3	0.29	0.40	72	25	3
Munro	20	6.6	0.31	0.29	0.34	69	24	7
Nazaroff, Evon	19	6.8	0.33	0.59	0.45	77	21	2
Nazaroff, Nick	24	6.8	0.27	0.31	0.27	77	19	4
Parvanian	24	7.3	0.42	0.38	0.24	87	10	3
Sani	25	6.7	0.86	0.25	0.48	77	20	3
Seibert	25	6.5	0.43	0.31	0.53	59	36	5
Shubian	23	7	0.54	0.33	0.33	73	23	4
Smith	22	6.7	0.46	0.81	0.33	66	28	6
Topjian-East	24	7.2	0.46	0.54	0.47	63	33	4
Topjian-West	22	7.1	0.36	0.43	0.27	80	16	4
Tufenkjian-Sanger	32	7.1	1.32	1.23	0.82	49	45	6
Tufenkjian-Clovis	21	6.1	0.43	0.48	0.32	82	14	4
Vasquez-no compost	22	6.5	0.29	0.3	0.26	90	9	1
Vasquez-compost	22	6.7	0.41	0.64	0.17	88	9	3
Van Gundy-no compost	22	6.7	0.55	0.71	0.27	69	28	3
Van Gundy-compost	21	6.6	0.93	1.15	0.40	70	26	4
Wulf	25	6.6	0.34	0.76	0.42	78	17	5

Soil analysis legend:

SP=Saturation percentage. Actually, it's the weight of water (in grams) required to completely saturate 100 grams of air-dry soil. The higher the number, the higher the water holding capacity of the soil. Corresponds well with soil texture:

- SP<20=sand to loamy sand
- 20-25=coarse sandy loam
- 25-30=sandy loam
- 30-35=fine sandy loam

EC=Electrical conductivity or salinity (the measure of the soil's salt content). Units are mmhos/cm (=dS/m).

If EC is <0.5, soil sealing and poor water penetration can occur
>1.5, vine growth may begin to suffer
>4, expect severe decline in vine growth and production

SAR=Sodium adsorption ratio. Sodium is not good for soil structure, and too much can cause soil sealing and reduced water penetration.

If SAR<6, no problem
6-9, cause for concern
>9, severe problem

Organic Matter=That portion of the soil which is derived from living sources. Organic matter increases the water and nutrient holding capacity of the soil.

Table 8. BIVS acreage and strategies for managing key vineyard pests: spider mites, weeds and powdery mildew.

GRWR	TARGET AREAS	BIVS ACRES	**MITES** LBS/AC OF PESTICIDES APPLIED ON BIVS ACREAGE IN 1998	**MITES** LBS/AC OF PESTICIDES HISTORICALLY APPLIED	**WEEDS** LBS/AC OF HERBICIDES APPLIED ON BIVS ACREAGE IN 1998	**WEEDS** LBS/AC OF HERBICIDES HISTORICALLY APPLIED	**MILDEW** LBS/AC OF MATERIALS APPLIED ON BIVS ACREAGE IN 1998	**MILDEW** LBS/AC OF MATERIALS HISTORICALLY APPLIED	CULTURAL & BIOLOGICAL CONTROLS -cover crops -compost -oiling roads -in-row tillage
Alles	bunch rot,	60		6 lb/ac omite (spot spray)	n/a	1 ¼ lb/ac karmex 2 lb/ac simazine	n/a	4 oz/ac rubigan 10 lb/ac sulfur dust	cover crop
Allred		20	0	6 lb/ac omite	1 pt/ac Roundup	3 lb/ac solicam	10 lb/ac sulfur dust	10 lb/ac sulfur dust	in-row tillage cover crop
Arakelian	est. young vines, soil	58	0	n/a	1 lb/ac simazine 1 ½ pt/ac Goal 1 qt/ac Roundup	n/a	10 lb/ac sulfur dust	n/a	cover crop
Bachant	soil, nematodes	40	n/a	6 lb/ac omite	n/a	0	procure 10 lb/ac sulfur dust	procure 10 lb/ac sulfur dust	cover crop in row tillage
Bennett	spider mites	10	0	6 lb/ac omite	2.6 pt/ac Roundup .62 lb/ac solicam .5 lb/ac simazine	1 qt/ac Roundup 1.2 lb/ac Goal 3 lb/ac solicam	7 lb/ac wettable sulfur	10 lb/ac sulfur dust	cover crop
Bishel	spider mites, leafhopper s	54	0	0	0	0	4 oz/ac sterol inhibitor 10 lb/ac sulfur dust	4 oz/ac rubigan 10 lb/ac sulfur dust	in-row tillage cover crop predator mite release
Bitter	weeds; mildew	70	None	None	None	None	15 lb/ac sulfur dust 2 lb/ac wettable sulfur	15 lb/ac sulfur dust 2 lb/ac wettable sulfur	in-row tillage

Table 8, con't

GRWR	TARGET AREAS	BIVS ACRES	**MITES** LBS/AC OF PESTICIDES APPLIED ON BIVS ACREAGE IN 1998	**MITES** LBS/AC OF PESTICIDES APPLIED HISTORICALLY	**WEEDS** LBS/AC OF HERBICIDES APPLIED ON BIVS ACREAGE IN 1998	**WEEDS** LBS/AC OF HERBICIDES APPLIED HISTORICALLY	**MILDEW** LBS/AC OF MATERIALS APPLIED ON BIVS ACREAGE IN 1998	**MILDEW** LBS/AC OF MATERIALS APPLIED HISTORICALLY	CULTURAL & BIOLOGICAL CONTROLS -cover crops -compost -oiling roads -in-row tillage
Boren	weeds, spider mites	10	0	6 lb/ac omite	8 oz/ac Roundup Ultra	1 qt/ac Roundup 3 lb/ac simazine 1.2 lb/ac Goal	10 lbs/ac sulfur dust	10 lbs/ac sulfur dust	in-row tillage oiling roads
Britz	spider mites, soil health	80	0	6 lb/ac omite	0	0	7 lb/ac wettable sulfur	10 lb/ac sulfur dust 4 oz/ac rubigan	french plow
Campbell	weeds, spider mites	32	3 gal/ac oil	6 lb/ac omite	14 oz/ac Roundup	1 qt/ac Roundup	10 lb/ac sulfur dust 3 oz/ac rubigan	10 lb/ac sulfur dust 3 oz/ac rubigan 7 lb/ac wettable sulfur	predator mites
Chooljian	weeds, leafhoppers	40	0	0	1 1/2 lb/ac simazine	3 lb/ac simazine	10 lb/ac sulfur dust	10 lb/ac sulfur dust	n/a
Crosno	weeds, spider mites	8	6 lb/ac omite	6 lb/ac omite	0	1 qt/ac Roundup	10 lb/ac sulfur dust	10 lb/ac sulfur dust	in-row tillage
CSUF-Conventional		10	0	6 lb/ac omite	1 qt/ac Roundup 3 ½ lb/ac karmex .7 lb/ac simazine 6 pt/ac Goal	1 qt/ac Roundup 3 ½ lb/ac karmex .7 lb/ac simazine 6 pt/ac Goal	n/a	n/a	cover crop
CSUF-Sustainable		10	0	0	0	0	n/a	n/a	cover crop
Feaver	OLR, spider mites, soil fertility	10	4 lb/ac omite	6 lb/ac omite	10.7 oz/ac Roundup	1 qt/ac Roundup ½ lb/ac Goal	n/a	n/a	in-row tillage

Table 8, con't

GRWR	TARGET AREAS	BIVS ACRES	**MITES** LBS/AC OF PESTICIDES APPLIED ON BIVS ACREAGE IN 1998	**MITES** LBS/AC OF PESTICIDES HISTORICALLYA PPLIED	**WEEDS** LBS/AC OF HERBICIDES APPLIED ON BIVS ACREAGE IN 1998	**WEEDS** LBS/AC OF HERBICIDES HISTORICALLYA PPLIED	**MILDEW** LBS/AC OF MATERIALS APPLIED ON BIVS ACREAGE IN 1998	**MILDEW** LBS/AC OF MATERIALS HISTORICALLY APPLIED	CULTURAL & BIOLOGICAL CONTROLS -cover crops (mites) -compost (mites) -oiling roads (mites) -in-row tillage
Felker	vine growth, soil fertility	7	0	new vines-n/a	1 qt/ac Roundup 6 pt/ac goal .7 lb/ac simazine	new vines-n/a	n/a	new vines-n/a	None
Forbes	spider mites, leafhopper s	10	0	6 lb/ac omite	6.4 oz/ac gramoxone	1/2 lb/ac simazine 1 qt/ac Roundup	10 lb/ac sulfur dust	10 lb/ac sulfur dust	overhead sprinklers for mite control lower nitrogen (for leafhoppers)
Fujioka	spider mites, powdery mildew	18	0	0	0	0	10 lb/ac sulfur dust	10 lb/ac sulfur dust	in-row tillage predator mite release
Harper	bunch rot, nematodes , phomopsis	8	0	6 lb/ac omite	1.7 pt/ac Roundup 1 pt/ac gramoxone	3 pt/ac Roundup 4 oz/ac Goal	2 1/2 oz/ac rubigan 7 lb/ac wettable sulfur 10 lb/ac sulfur dust	2 1/2 oz/ac rubigan 7 lb/ac wettable sulfur 10 lb/ac sulfur dust	cover crop
Holmquist	weeds	20	0	new vines-n/a	16 oz/ac Goal 12 oz/ac gramoxone 16 oz/ac Roundup (spot treat)	new vines-n/a	n/a	new vines-n/a	cover crop in row tillage

Table 8, con't

GROWER	TARGET AREAS	ACRES IN PROGRAM	MITES LBS/AC OF PESTICIDES APPLIED ON BIVS ACREAGE IN 1998	MITES LBS/AC OF PESTICIDES APPLIED HISTORICALLY	WEEDS LBS/AC OF HERBICIDES APPLIED ON BIVS ACREAGE IN 1998	WEEDS LBS/AC OF HERBICIDES APPLIED HISTORICALLY	MILDEW LBS/AC OF MATERIALS APPLIED ON BIVS ACREAGE IN 1998	MILDEW LBS/AC OF MATERIALS APPLIED HISTORICALLY	CULTURAL & BIOLOGICAL CONTROLS -cover crops (mites) -compost (mites) -oiling roads (mites) -in-row tillage
Jue	spider mites, weeds	30	0	6 lb/ac omite	0	1 qt/ac Roundup 1 gal/ac surflan 3 ½ lb/ac karmex 1 lb/ac simazine	7 lb/ac wettable sulfur 10 lb/ac sulfur dust 4 oz/ac procure	10 lb/ac sulfur dust	cover crop in-row tillage
Kangas	weeds, leafhoppers	4	0	0	1.6 qt/ac Roundup Ultra	2 qt/ac Roundup 1 gal/ac surflan	10 lb/ac sulfur dust	10 lb/ac sulfur dust	hand raking & hand weeding
Khasigian	nematodes, leafhoppers, mites, weeds	10	0	6 lb/ac omite	3 lb/ac solicam	1 1/2 lb/ac simazine 1 pt/ac Roundup	10 lb/ac sulfur dust	10 lb/ac sulfur dust	cover crop compost
Lightner	poor vine growth	10	0	0	1 pt/ac Roundup	1 pt/ac Roundup	10 lb/ac sulfur dust 7 lb/ac wettable sulfur	10 lb/ac sulfur dust 7 lb/ac wettalbe sulfur	in-row tillage
Loewen	weeds, soil fertility	15	0	0	0	1 qt/ac Roundup	10 lb/ac sulfur dust 7 lb/ac ralley (every other row)	10 lb/ac sulfur dust 7 lb/ac ralley (every other row)	in-row tillage
Meisner	OLR, leafhoppers, spider mites	20	0	0	1 1/2 lb/ac simazine 1 lb/ac solicam 1 qt/ac Roundup	3 lb/ac simazine	10 lb/ac sulfur dust 7 lb/ac wettable sulfur	10 lb/ac sulfur dust 7 lb/ac wettable sulfur	cover crop sanitation

Table 8, con't

GRWR	TARGET AREAS	BIVS ACRES	**MITES** LBS/AC OF PESTICIDES APPLIED ON BIVS ACREAGE IN 1998	**MITES** LBS/AC OF PESTICIDES APPLIED HISTORICALLY	**WEEDS** LBS/AC OF HERBICIDES APPLIED ON BIVS ACREAGE IN 1998	**WEEDS** LBS/AC OF HERBICIDES APPLIED HISTORICALLY	**MILDEW** LBS/AC OF MATERIALS APPLIED ON BIVS ACREAGE IN 1998	**MILDEW** LBS/AC OF MATERIALS APPLIED HISTORICALLY	CULTURAL & BIOLOGICAL CONTROLS -cover crops (mites) -compost (mites) -oiling roads (mites) -in-row tillage
Munro	soil fertility, nematodes	20	0	0	0	1 qt/ac Roundup (spot spray) 3 pt/ac gramoxone (spot spray)	10 lb/ac sulfur dust 7 lb/ac wettable sulfur	10 lb/ac sulfur dust 7 lb/ac wettable sulfur	in-row tillage
E. Nazaroff	soil fertility	5	1.9 pt/ac Kelthane (spot spray)	5 lb/ac omite (spot spray)	0	1 pt/ac Roundup (spot spray)	n/a	n/a	in-row tillage
N. Nazaroff	mildew	5	0	0	1 lb/ac simazine 1 pt/ac Roundup 1 lb/ac solicam	1 lb/ac simazine 1 pt/ac Roundup	n/a	10 lb/ac sulfur /ac procure	cover crop blow off berms
Parvanian	mildew	10	0	0	3 pt/ac gramoxone	1 gal/ac surflan 1 lb/ac simazine 1 qt/ac Roundup	4 lb/ac wettable sulfur	4 lb/ac wettable sulfur 10 lb/ac sulfur dust	None
Sani	spider mites, OLR	10	5 lb/ac omite	5 lb/ac omite	0	n/a	n/a	n/a	in-row tillage
Seibert	spider mites	20	2.25 gal/ac oil	6 lb/ac omite	0	1 lb/ac simazine 1 gal/ac surflan 1 qt/ac Roundup	7 lb/ac wettable sulfur	10 lb/ac sulfur dust 7 lb/ac wettable sulfur	cover crop in-row tillage
Shubian	OLR	20	0	0	1 pt/ac Roundup 1 lb/ac simazine	n/a	n/a	n/a	n/a
Smith	weeds, spider mites	85	0	0 lb/ac Omite	1 qt/ac Roundup	1 qt/ac Roundup	10 lb/ac sulfur dust 7 lb/ac wettable sulfur	7 lb/ac wettable sulfur	cover crop in-row tillage

Table 8, con't

GRWR	TARGET AREAS	BIVS ACRES	**MITES** LBS/AC OF PESTICIDES APPLIED ON BIVS ACREAGE IN 1998	**MITES** LBS/AC OF PESTICIDES APPLIED HISTORICALLY	**WEEDS** LBS/AC OF HERBICIDES APPLIED ON BIVS ACREAGE IN 1998	**WEEDS** LBS/AC OF HERBICIDES APPLIED HISTORICALLY	**MILDEW** LBS/AC OF MATERIALS APPLIED ON BIVS ACREAGE IN 1998	**MILDEW** LBS/AC OF MATERIALS APPLIED HISTORICALLY	CULTURAL & BIOLOGICAL CONTROLS -cover crops -compost -oiling roads -in-row tillage
Topjian	weeds	53 1/2	0	0	13.6 oz/ac Roundup Ultra .84 lb/ac simazine 1.6 pt/ac surflan	1 qt/ac Roundup	7 lb/ac wettable sulfur 10 lb/ac sulfur dust 4 oz/ac rubigan	7 lb/ac wettalbe sulfur 10 lb/ac sulfur dust	n/a
Tufenkjian	weeds, leafhopper s	20	0	0	n/a	6.4 pt/ac Goal 3.2 qt/ac surflan 3 pt/ac gramoxone	7 lb/ac wettable sulfur 11 lb/ac sulfur dust	7 lb/ac wettable sulfur 11 lb/ac sulfur dust	cover crop
Topjian	weeds	53 1/2	0	0	13.6 oz/ac Roundup Ultra .84 lb/ac simazine 1.6 pt/ac surflan	1 qt/ac Roundup	7 lb/ac wettable sulfur 10 lb/ac sulfur dust 4 oz/ac rubigan	7 lb/ac wettalbe sulfur 10 lb/ac sulfur dust	n/a
Tufenkjian	weeds, leafhopper s	20	0	0	n/a	6.4 pt/ac Goal 3.2 qt/ac surflan 3 pt/ac gramoxone	7 lb/ac wettable sulfur 11 lb/ac sulfur dust	7 lb/ac wettable sulfur 11 lb/ac sulfur dust	cover crop
Van Gundy	mildew, nematodes	31.5	0	0	7.5 oz/ac Roundup Ultra 5.6 oz/ac Goal	1 qt/ac Roundup 1/2 lb/ac Goal 1 lb/ac simazine	n/a	11 lb/ac sulfur dust 1.75 lb/ac thiolux 4 oz/ac rubigan	cover crop compost
Vasquez	nematodes, spider mites	10	0	0	3 lb/ac simazine	3 lb/ac simazine 1 qt/ac Roundup	n/a	n/a	predator mite release compost
Wulf	OLR, soil fertility	10	0	0	1 qt/ac Roundup	1 qt/ac Roundup	n/a	n/a	cover crop